

Relocatable Coastal Modeling System

Daniel N Fox

Naval Research Laboratory Code 7323

Stennis Space Center, MS 39529-5004

Phone: (228) 688-5588 Fax: (228) 688-4759 Email: fox@nrlssc.navy.mil

Award #: N0001499WX30113

<http://www7320.nrlssc.navy.mil/modas>

LONG-TERM GOAL

The development of limited-area, open-boundary, nowcast/forecast systems that have a stand-alone, shipboard capability and which can be applied around the globe, especially in shallow coastal waters.

OBJECTIVES

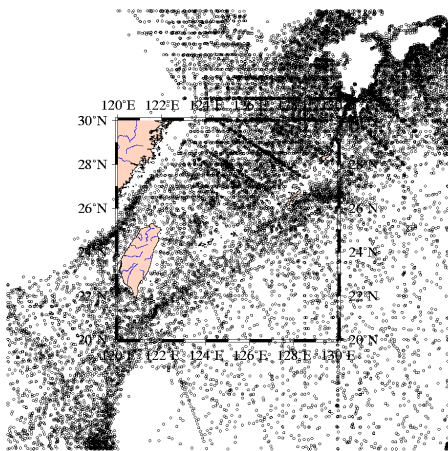
The transition of a scalable (workstation through high-performance computing platform) system for producing optimal regional and tactical scale ocean nowcasts and forecasts to related 6.4 projects.

APPROACH

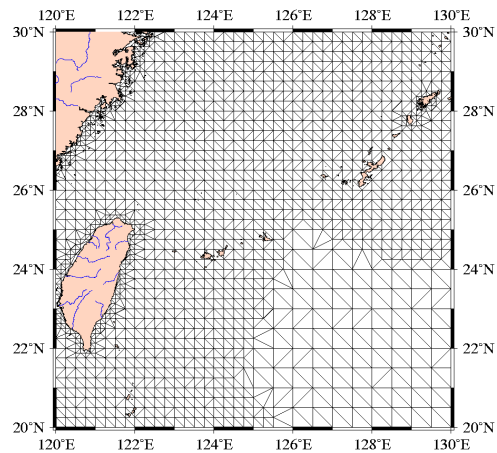
Adapt, develop, and evaluate the components necessary for a limited-area, coastal nowcast/forecast system and integrate these components into a demonstration system for evaluation, comparison, and transition. This system is called NOMADS, for NRL Ocean Models and Assimilation Demonstration System, and is outlined below. The key modules in the present version of NOMADS are the Modular Ocean Data Assimilation System (MODAS), a set of programs and scripts for performing optimum interpolation using a first-guess derived from satellite measured altimetry (SSH) and sea surface temperatures (SST), plus a relocatable version of the Princeton Ocean Model (POM), including tides. Future versions will include wave, and surf modules. A continuous, real-time assimilation variant of the system for submarine use is also being developed. The entire system is constructed using a “modular” philosophy, permitting rapid prototyping and testing of new algorithms and capabilities.

The figures below and on the following pages outline the process of using satellite altimetry and temperature measurements to form a “synthetic profile”. The Altimeter Data Fusion Center at NAVOCEANO uses a subset of MODAS modules to produce daily 1/8 degree analyses of SSH and SST which are used by the full version of MODAS to generate a full 3-dimensional grid of temperature and salinity, into which in situ BT’s and CTD’s are assimilated. The synthetic BT algorithms are based on a re-analysis of approximately 100 years of MOODS data, totaling nearly 2 million profiles. Figure 1a displays the locations of data used to derive regressions in the vicinity of Korea, for example. Regression relationships are derived to relate surface height and temperature to subsurface temperature and a companion set of coefficients is derived to estimate salinity from temperature. These relationships are stored on a variable-resolution grid (illustrated in figure 1b below) with sampling of 1 degree in deep water (and in data-sparse areas) and decreasing to 1/8 degree in the littoral.

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 30 SEP 1999		2. REPORT TYPE		3. DATES COVERED 00-00-1999 to 00-00-1999	
4. TITLE AND SUBTITLE Relocatable Coastal Modeling System				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Research Laboratory, Code 7323, Stennis Space Center, MS, 39529				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



1a: Historical data locations

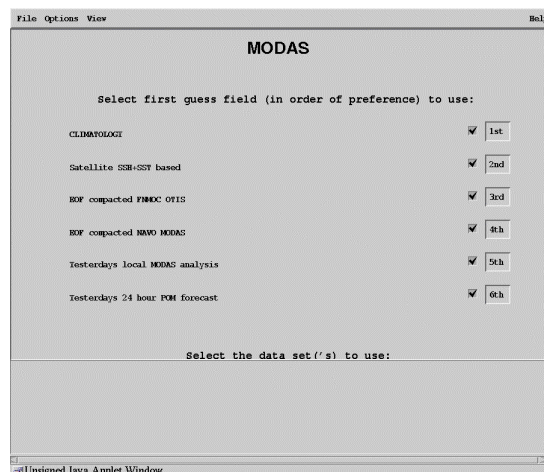


1b: Variable resolution grid

WORK COMPLETED

An initial version of MODAS2 was beta tested during the NATO Rapid Response / Strong Resolve '98 exercise off Sierra de Retin in southwestern Spain. As a result, significant improvements were made and the overall database structure revised to support the variable resolution grid. The changes were significant enough that this version is referred to as MODAS2.1, which is now operational at NAVO.

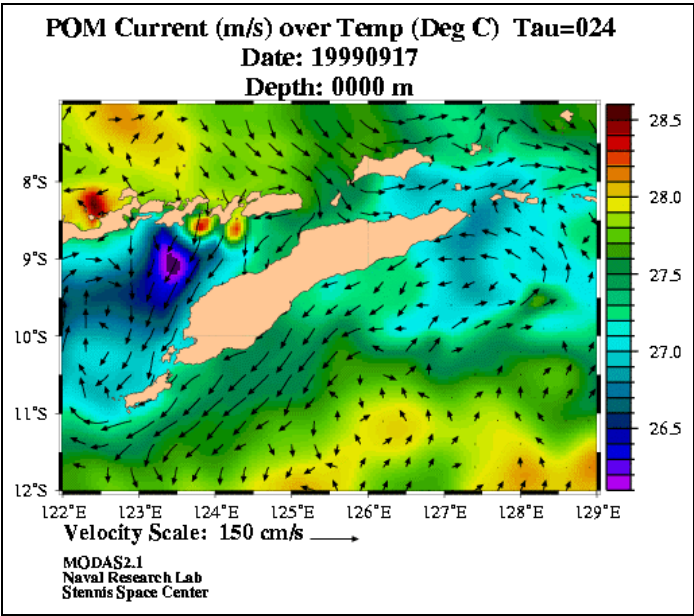
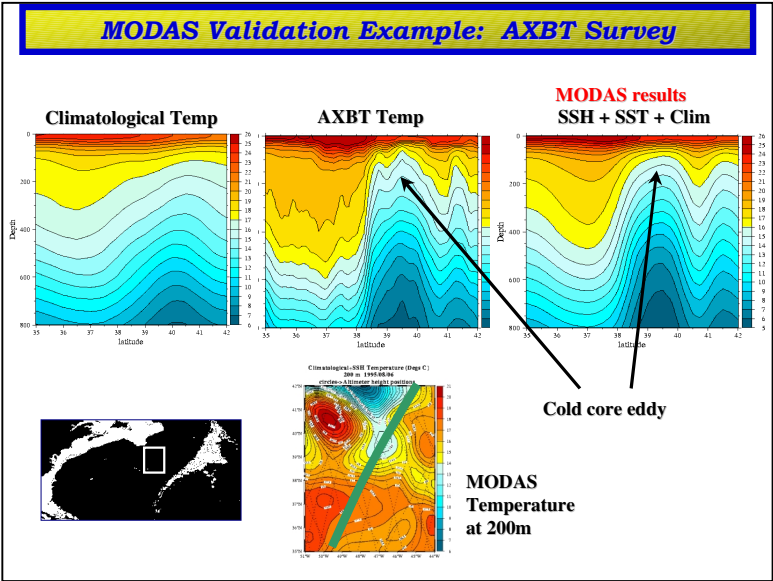
The NOMADS interface is being replaced by a system-independent, web-based version. The old version was hard-coded in the C++ computer language, which made rapid updates difficult. A new version was written in Javascript which ran inside the user's web browser plus Perl CGI scripts which ran on a webserver. This permitted the user to run MODAS (and POM and other modules as they are added) on a Unix server system while sitting at any computer that supports a web browser (such as their Windows '95 or NT systems, or a TAC-IV). Some limitations were encountered in the Perl/Javascript approach and we have switched to a pure Java approach (example screen shot below).



RESULTS

The first figure below shows an example of the MODAS synthetic BT algorithms off the northeast US. Vertical sections display climatology (left), the actual in situ XBT survey (middle), and the MODAS synthetics (right). It is important to note that no in situ BT data was used in the MODAS analysis shown. The “buried” eddy revealed here was reproduced solely from satellite measured quantities applied to the MODAS synthetic profile algorithms.

The second figure shows a 24-hour forecast of surface currents and temperature from the relocatable POM model in the vicinity of East Timor.



IMPACT/APPLICATION

The present version of the MODAS climatology and synthetic profile algorithms represent a significant advance in operational oceanography. It is now possible to generate nowcasts which are significantly better than climatogoy virtually anywhere in the world's oceans, from deep water through the littoral, based solely on satellite remote sensed properties. These nowcasts provide an accurate estimate of the temperature and salinity structure which can be further refined by including in situ BT and CTD data, where available.

TRANSITIONS

The initial version of MODAS2.0 was transitioned to the 6.4 Rapid Response project, where it was used to provide the oceanography and currents during the NATO Rapid Response '98 rapid environmental assessment (REA) and the related Strong Resolve '98 NATO naval exercise.

After significant improvements, MODAS2.1 was transitioned to the 6.4 ROAMER project, which delivered it to NAVOCEANO where it is now operational and producing nowcasts for over 30 regions and relocatable POM forecasts for several of those, as needed. These analyses vary from special support areas to large regional areas which are sent to the regional METOC centers where they are used to initialize their existing MODAS1.6 systems.

RELATED PROJECTS

This project works closely with the 6.4 On-Scene Tactical Ocean Forecast Capability, which this year delivered a special "light" version of MODAS to the NITES-I AFLOAT project (formerly TESS-NC) and is now working on delivering a full version of MODAS for the NITES-I ASHORE system where it will co-exist with TAMS-RT (COAMPS) on large SGI computers at selected regional centers.

The project also works closely with the 6.4 ROAMER project, which handles transitions of NOMADS modules to NAVOCEANO. It also provided the MODAS modules which the NRL Altimeter Support Group is using to transition the altimetry processing system to the NAVO Altimeter Data Fusion Center.

This project relies on other 6.1 and 6.2 projects to do the initial R&D of the models and assimilation methods it will use. The relocatable coastal ocean model is being developed in the 6.2 Model Evaluation and Performance Project; techniques for nesting this model in regional and global large scale models are being developed in the 6.2 Ocean Data Assimilation Project (formerly DART); wave models are being developed in the 6.4 Surf Model Upgrade project.

PUBLICATIONS

Carnes, M.R., D.N. Fox, R.C. Rhodes, O.M. Smedstad, 1996: Data Assimilation in a North Pacific Ocean Monitoring and Prediction System, in "Modern Approaches to Data Assimilation", edited by P. Malanote-Rizzoli. Elsevier Oceanography Series, Volume 61. Elsevier. Pp 319-345.

Smedstad, O.M., D.N. Fox, H.E. Hurlburt, G. Jacobs, E.J. Metzger, J.L. Mitchell, 1997: Altimeter Data Assimilation into an 1/8 degree eddy resolving model of the Pacific Ocean, in "Data Assimilation in Meteorology and Oceanography: Theory and Practice", edited by Michael Ghil, M. Kimito, and others, published by the Japan Meteorology Society.

Harding, J., D.N. Fox, M.R. Carnes, R.C. Rhodes, 1998: "NRL Ocean Modeling and Assimilation Demonstration System (NOMADS)". Presented at AGU Ocean Sciences Meeting, Feb 9-12, 1998. (Special Allan Robinson tribute session).

Sakalaukus, P.J., D.N. Fox, A.L. Perkins, L.F. Smedstad, "An Interactive HTML Ocean Nowcast GUI Based on Perl and JavaScript", 1999, Computers and Geosciences 25 (1999), pp 83-90.

"User's Manual for the Modular Ocean Data Assimilation System (MODAS) Version 2.1", May 1999, PSI Technical Report S-285. Planning Systems Inc., Slidell, LA.